

CLAIMS

1. A process for fabricating a thin-film device,
said process comprising the steps of:

5 forming a conducting layer composed of an
anodically oxidizable metal on a substrate;

etching said conducting layer to form a
plurality of bus lines having upper surfaces parallel to
said substrate and inclined side surfaces and connection
portions electrically connected to said bus lines and
10 having upper surfaces parallel to said substrate and
inclined side surfaces; and

anodically oxidizing said bus lines and
said connection portions so that said bus lines and said
connection portions include inner conducting portions and
15 outer insulating oxide films covering said inner
conducting portions, respectively.

2. A process according to claim 1, wherein said
etching step is carried out so that the side surfaces of
said bus lines and the side surfaces of said connection
20 portions are inclined at angles within the range from 20
degrees to 60 degrees, an average, with respect to said
substrate.

3. A process according to claim 2, wherein said
etching step is carried out so that the side surfaces of
25 said bus lines and the side surfaces of said connection
portions are inclined at angles within the range from 30
degrees to 50 degrees, an average, with respect to said
substrate.

4. A process according to claim 1, further
30 comprising the step for forming a mask on said conducting
layer prior to said etching step, and the step for ashing
said substrate including said mask between said mask
forming step and said etching step.

5. A process according to claim 1, further
35 comprising the step for forming a mask on said conducting
layer and the step for baking said mask prior to said
etching step, wherein the temperature for baking said

mask in said baking step is so set that said mask will have a relatively small rigidity so that an outer portion of said mask is pushed up from said conducting layer due to a reaction gas in said etching step.

5 6. A process according to claim 5, wherein the temperature for baking said mask in said baking step is not higher than 115°C.

10 7. A process according to claim 5, wherein said etching step is carried out so that the side surfaces of said bus lines and the side surfaces of said connection portions are outwardly convex.

15 8. A process according to claim 5, wherein said etching step is carried out so that the angles between the upper surfaces and the side surfaces of said bus lines and of said connection portions are obtuse angles.

20 9. A process according to claim 1, further comprising an ionic milling step for removing part of the outer oxide films to expose the inner conducting portions after said step of anodic oxidation.

25 10. A thin-film device comprising at least a substrate, a plurality of bus lines provided on said substrate, and connection portions electrically connected to said bus lines, said bus lines and said connection portions being formed of an anodically oxidizable metal and having upper surfaces parallel to said substrate and inclined side surfaces, respectively, said bus lines and said connection portions including inner conducting portions and outer insulating oxide portions formed by anodic oxidation to cover said inner conducting portions, respectively.

30 11. A thin-film device according to claim 10, wherein said thin-film device is a substrate including thin-film transistors.

35 12. A thin-film device according to claim 11, wherein the substrate including said thin-film transistors is a substrate of a liquid crystal display device, said bus lines are gate bus lines, and said

connection portions are gate electrodes of said thin-film transistors, said thin-film device further comprising an insulating layer covering said bus lines and said connection portions, a plurality of drain bus lines
5 arranged on said insulating layer to cross said gate bus lines, and a plurality of pixel electrodes.

13. A thin-film device according to claim 12, further comprising storage capacitor electrodes arranged on said substrate and made of the same material as said
10 gate bus lines and said connection portions.

14. A thin-film device according to claim 10, wherein said thin-film device is an MIM diode.

15. A thin-film device according to claim 10, wherein said anodically oxidizable metal comprises at least one selected from the group consisting of Al, Ta, Al-Si, Al-Ta, Al-Zr, Al-Nd, Al-Pd, Al-W, Al-Ti, Al-Ti-B, Al-Sc, Al-Y, Al-Pt, and Al-Pa.

16. A thin-film device according to claim 10, wherein the side surfaces of said bus lines and the side
20 surfaces of said connection portions are inclined at angles within the range from 20 degrees to 60 degrees, on average, with respect to said substrate.

17. A thin-film device according to claim 16, wherein the side surfaces of said bus lines and the side
25 surfaces of said connection portions are inclined at angles within the range of from 30 degrees to 50 degrees, on average, with respect to said substrate.

18. A thin-film device according to claim 10, wherein the side surfaces of said bus lines and the side
30 surfaces of said connection portions are outwardly convex.

19. A thin-film device according to claim 10, wherein the angles between the upper surfaces and the side surfaces of said bus lines and of said connection
35 portions are obtuse angles.

20. A thin-film device according to claim 10, wherein at least two outer oxide films of said bus lines

and said connection portions contact each other and the contacting outer oxide films electrically isolate the inner conducting portions covered by said contacting outer oxide films.

5 21. A thin-film device according to claim 10,
wherein a conducting portion separate from said bus lines
and said connecting portions is arranged close to said
bus lines or said connecting portions; said separate
conducting portion includes an inner conducting portion
10 and an outer insulating oxide portion covering said inner
conducting portion; the outer oxide film of said separate
conducting portion contacts at least one outer oxide film
of said bus lines and of said connection portions; and
said contacting outer oxide films electrically isolate
15 the inner conducting portions that are covered by said
contacting outer oxide films.

22. A process for fabricating a thin-film device,
said process comprising the steps of:

forming a conducting layer composed of an
20 anodically oxidizable metal on a substrate;

etching said conducting layer in a
predetermined shape;

forming a second oxide film on said
conducting layer by anodic oxidation after a first oxide
25 film with a thickness is formed on said conducting layer;
and

washing said substrate, whereby said first
oxide film is removed by said washing and said second
oxide film is not removed by said washing but remains on
30 said conducting layer so as to cover said conducting
layer.

23. A process according to claim 22, wherein said
anodically oxidizable metal includes at least one of Al,
Ta, Al-Si, Al-Ta, Al-Zr, Al-Nd, Al-Pd, Al-W, Al-Ti, Al-
35 Ti-B, Al-Sc, Al-Y, Al-Pt, and Al-Pa.

24. A process according to claim 22, wherein said
first oxide film is one of a naturally oxidized film or a

hydrated film formed on the surface of said anodically oxidizable metal.

25. A process according to claim 22, wherein said first oxide film has a thickness from 50 nm to 100 nm.

5 26. A process according to claim 22, wherein said washing step is executed using ultrasonic waves of not lower than 200 KHz.

10 27. A process according to claim 22, wherein said thin-film device is a substrate including thin-film transistors.

15 28. A process according to claim 27, further comprising a step for forming an insulating film on said substrate and a step for forming a semiconductor layer on said substrate after the second oxide film has been formed, wherein the step for etching said conducting layer forms gate electrodes and gate wirings.

20 29. A process according to claim 27, further comprising a step for forming a semiconductor layer on said substrate and a step for forming an insulating film on said substrate prior to forming said conducting layer, wherein the step for etching said conducting layer forms gate electrodes and gate wirings.

25 30. A process according to claim 22, wherein the step for etching said conducting layer forms gate electrodes having upper surfaces parallel to said substrate and inclined side surfaces.

31. A process for fabricating a thin-film device, said process comprising the steps of:

30 forming a semiconductor layer having a predetermined shape on a substrate;

 forming an insulating film on said substrate to cover said semiconductor layer;

35 forming a conducting layer composed of an anodically oxidizable metal on said substrate in such a shape as to cover a portion of said semiconductor layer and to form gate electrodes having upper surfaces parallel to said substrate and inclined side surfaces;

anodically oxidizing said gate electrodes;
forming said insulating film into a
predetermined shape using said gate electrodes including
the anodically oxidized film as a mask; and

5 injecting impurities into said
semiconductor layer using said gate electrodes including
said anodically oxidized film and said insulating film as
a mask to form an offset in said semiconductor layer.

10 32. A process according to claim 31, wherein said
thin-film device is a substrate including thin-film
transistors.

33. A process according to claim 31, wherein said
anodically oxidizable metal includes at least one of Al,
Ta, Al-Si, Al-Ta, Al-Zr, Al-Nd, Al-Pd, Al-W, Al-Ti, Al-
15 Ti-B, Al-Sc, Al-Y, Al-Pt, and Al-Pa.

34. A process according to claim 31, wherein said
anodically oxidized film is a barrier-type anodically
oxidized film.

20 35. A process according to claim 31, wherein said
semiconductor layer comprises a polycrystalline silicone.

36. A process according to claim 31, wherein an
initial current density at the time of executing the
anodic oxidation is not smaller than 2.0 mA/cm^2 but is
not larger than 3.0 mA/cm^2 .

25 37. A process according to claim 31, wherein the
step for forming said gate electrodes comprises the step
for forming a gate electrode layer and the step of
patterning the gate electrode layer based on either ionic
milling or dry-etching.

30 38. A process according to claim 31, wherein a
masking resist is formed on said conducting layer and is
post-baked at a temperature of not lower than 130°C but
not higher than 200°C , prior to forming said gate
electrode.

35 39. A thin-film device comprising a substrate, a
semiconductor layer formed in a predetermined shape on

said substrate, an insulating film covering a portion of
said semiconductor layer, a gate electrode formed on said
insulating film, and an anodically oxidized film of said
gate electrode formed on said insulating film so as to
5 cover said gate electrodes, said anodically oxidized film
having a shape as viewed from above which is identical to
the shape of said insulating film as viewed from above
and having an annular portion in annular contact with
said insulating film about said gate electrode, a portion
10 of said semiconductor layer located on the outer side of
said insulating film forming a source electrode and a
drain electrode, and a portion of said semiconductor
layer covered by said annular portion of said anodically
oxidized film forming an offset on the inner side of said
15 insulating film.

40. A liquid crystal display device, comprising:
a first substrate comprising the thin-film
device having a plurality of thin-film transistors
according to claim 10 or 39;
20 a second substrate opposite to the first
substrate; and
a liquid crystal layer filled between the
first and second substrates.